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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/737,022	12/15/2003	Camelia Rusu	LAMIP180/P1170X	5595
22434	7590	02/14/2006	EXAMINER	
BEYER WEAVER & THOMAS LLP P.O. BOX 70250 OAKLAND, CA 94612-0250			ANGADI, MAKI A	
			ART UNIT	PAPER NUMBER
			1765	
DATE MAILED: 02/14/2006				

Please find below and/or attached an Office communication concerning this application or proceeding.

### Period for Reply

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 15 December 2003.  
2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.  
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-16 is/are pending in the application.  
4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-16 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All    b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)  
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)  
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date 5/05/2005.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_  
5) ☐ Notice of Informal Patent Application (PTO-152)  
6) ☐ Other: \_\_\_\_\_

## **DETAILED ACTION**

### ***Election/Restrictions***

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:
  - I. Claims 1-16 drawn to a method for etching a high aspect ratio features classified in class 438 subclass 706
  - II. Claims 17-18 drawn to an apparatus for etching classified in class 156 subclass 345.1.

The inventions are distinct, each from the other because of the following reasons: Inventions I and II are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case, the apparatus can be adapted for dry etching of different patterns other than high aspect ratio features during the device fabrication.

Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

Because these inventions are distinct for the reasons given above and the search required for Invention I is not required for Invention II, restriction for examination purposes as indicated is proper.

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2. During a telephone conversation with Attorney Michael Lee on 12/21/2005 a provisional election was made with traverse to prosecute the invention of I claims 1-16. Affirmation of this election must be made by applicant in replying to this Office Action. Claims 17 and 18 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b) as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and

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invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

1. *Claims 1-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Loewenhardt (US Pub No. 2004/0221958) in view of Gorin (US Patent No. 4, 464, 223) and further view of Wolf Silicon Processing for the VLSI Era, Vol.1 Lattice Press (1986).*

The applied reference has a common assignee with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art only under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 103(a) might be overcome by: (1) a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not an invention "by another"; (2) a showing of a date of invention for the claimed subject matter of the application which corresponds to subject matter disclosed but not claimed in the reference, prior to the effective U.S. filing date of the reference under 37 CFR 1.131; or (3) an oath or declaration under 37 CFR 1.130 stating that the application and reference are currently owned by the same party and that the inventor named in the application is the prior inventor under 35 U.S.C. 104, together with a terminal

disclaimer in accordance with 37 CFR 1.321(c). This rejection might also be overcome by showing that the reference is disqualified under 35 U.S.C. 103(c) as prior art in a rejection under 35 U.S.C. 103(a). See MPEP § 706.02(l)(1) and § 706.02(l)(2).

*As to claims 1*, Loewenhardt discloses a method for etching a high aspect ratio feature through a mask into a layer to be etched over a substrate (paragraph 0004, lines 1-4) comprising: placing the substrate in a process chamber (paragraph 0007, lines 1-3, paragraph 0008, lines 1-4), which is able to provide RF power at a first frequency (paragraph 0007, lines 11-13), a second frequency (paragraph 0007, lines 13-18), providing an etchant gas to the process chamber (paragraph 0007, lines 4-6), providing a first etch step where the first frequency is at a first power level, the second frequency is at a second power level, wherein the first etch etches a feature in the layer to be etched (paragraph 0019, lines 10-14). Loewenhardt does not disclose the second etch step where the first frequency is at a fourth frequency power level, the second frequency is at a fifth power level, and the third frequency is at sixth power level. However, Loewenhardt discloses that the RF modulation frequency may be used to control the ratio of F+ to CF+ that determines the selectivity ratio (paragraph 0021, lines 1-8). Gorin teaches that the etch rate for silicon dioxide layer changes depending on the RF frequency and power levels (col. 5, lines 10-30) which appears to reflect a result-effective variable which can be optimized. See MPEP § 2144.05

II. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Loewenhardt to select frequency ranges for etching because Gorin teaches that the choice of modulation frequency depends on etch rate and uniformity.

*As to claims 2 and 3*, Loewenhardt discloses that the layer to be etched is a dielectric layer and it is a single layer (paragraph 0019 lines 4-8).

*As to claims 4*, Loewenhardt discloses the use of a single dielectric layer but does not disclose that the layer is uniform. Wolf teaches the importance of layer uniformity in achieving reproducible results in dry etching. Therefore, it would be obvious to one of ordinary skill at the time the invention was made to modify Loewenhardt to select uniform single dielectric layer because Wolf illustrates the importance of reproducibility in plasma etching processes for fabricating devices that can achieve long term stability (page 575).

*As to claims 5 and 9*, Loewenhardt does not disclose a third etch step. Loewenhardt teaches that one can tailor etch rate according to the type of etch e.g. in etching a high aspect ratio contact or a low-k dielectric material that require the modulation of RF frequency (paragraph 0024). Gorin teaches that the choice of operating parameters depend on etch uniformity, etch selectivity and improved dimensional control. The etching of dielectric layers appears to be dependent on several result effective variables that need to be optimized to

achieve high aspect ratios. See MPEP § 2144.05 II. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Loewenhardt to select additional steps for etching because Gorin illustrates the dependence of final etch results on the choice of operating parameter.

*As to claims 6 and 10* Loewenhardt discloses that the first frequency is between 100 kHz and 10 MHz, the second frequency is between 10 MHz to about 35 MHz (paragraph 0017 lines 2-8). Loewenhardt does not expressly disclose the use of third frequency. However, Gorin teaches that the etch rate for silicon dioxide layer changes depending on the RF frequency and power levels (col. 5, lines 10-30) which appears to reflect a result-effective variable which can be optimized. See MPEP § 2144.05 II. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Loewenhardt to select frequency ranges for uniform etching because Gorin illustrates that the choice of modulation frequency depends on etch rate and uniformity.

*As to claim 7,* Loewenhardt discloses that the first frequency is about 2 MHz and the second frequency is about 27 MHz (paragraph 0017, lines 5-8), but does not disclose the third frequency. However, Gorin teaches that the etch rate for silicon dioxide layer changes depending on the RF frequency and power



levels (col. 5, lines 10-30) which appears to reflect a result-effective variable which can be optimized. See MPEP § 2144.05 II. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Loewenhardt to select frequency ranges for etching because Gorin illustrates that the choice of modulation frequency depends on etch rate and uniformity.

*As to claim 8*, Loewenhardt discloses that etchant gas comprises a component selected from the group of fluorocarbon (paragraph 0015, lines 1-8) but does not expressly disclose hydrofluorcarbon. Wolf teaches the use of fluorocarbon and hydro-fluorocarbon gases in dry etching processes (page 547). Therefore, it would be obvious to one of ordinary skill at the time the invention was made to modify Loewenhardt to select hydrofluorcarbon gases for achieving high aspect ratio layers because Wolf illustrates that using hydrofluorcarbon gases one can achieve uniform etching rate (page 549).

*As to claim 11*, Loewenhardt discloses that a semiconductor device is formed by the method (claim 19).

*As to claim 12*, Loewenhardt discloses a method for etching a high aspect ratio feature through a mask into a layer to be etched over a substrate (paragraph 0004, lines 1-4) comprising: placing the substrate in a process

chamber (paragraph 0007, lines 1-3, paragraph 0008, lines 1-4), which is able to provide RF power at a first frequency (paragraph 0007, lines 11-13), a second frequency (paragraph 0007, lines 13-18), providing an etchant gas to the process chamber (paragraph 0007, lines 4-6), providing a first etch step where the first frequency is at a first power level, the second frequency is at a second power level, wherein the first etch etches a feature in the layer to be etched (paragraph 0019, lines 10-14). Loewenhardt does not disclose the second etch step where the first frequency, the second frequency, and the third frequency, with at least one of the frequencies at a different power level than that used in the first etch to etch the feature in the etch layer to a second depth greater than the first depth. However, Loewenhardt discloses that the RF modulation frequency may be used to control the ratio of F+ to CF+ that determines the selectivity ratio (paragraph 0021, lines 1-8). Gorin teaches that the etch rate for silicon dioxide layer changes depending on the RF frequency and power levels (col. 5, lines 10-30) which appears to reflect a result-effective variable which can be optimized. See MPEP § 2144.05 II. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Loewenhardt to select frequency ranges for etching because Gorin teaches that the choice of modulation frequency depends on etch rate and uniformity.

*As to claim 13 and 14*, Loewenhardt discloses that the layer to be etched is a dielectric layer and it is a single layer (paragraph 0019 lines 4-8).

*As to claim 15*, Loewenhardt discloses the use of a single dielectric layer but does not disclose that the layer is uniform. Wolf teaches the importance of layer uniformity in achieving reproducible results in dry etching. Therefore, it would be obvious to one of ordinary skill at the time the invention was made to modify Loewenhardt to select uniform single dielectric layer because Wolf illustrates the importance of reproducibility in plasma etching processes for fabricating devices that can achieve long term stability (page 575).

*As to claim 16*, Loewenhardt discloses that the first frequency is between 100 kHz and 10 MHz; the second frequency is between 10 MHz to about 35 MHz (paragraph 0017 lines 2-8). Loewenhardt does not expressly disclose the use of third frequency. However, Gorin teaches that the etch rate for silicon dioxide layer changes depending on the RF frequency and power levels (col. 5, lines 10-30) which appears to reflect a result-effective variable which can be optimized. See MPEP § 2144.05 II. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Loewenhardt to select frequency ranges for uniform etching because Gorin illustrates that the choice of modulation frequency depends on etch rate and uniformity.

***Conclusion***

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Rossman (US Patent No. 6,821,577) discloses staggered in-situ deposition and etching of a dielectric layer for HDP CVD.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Maki A. Angadi whose telephone number is 571-272-8213. The examiner can normally be reached on 8 AM to 4.30 PM. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine G. Norton can be reached on 571-272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

MA

NADINE G. NORTON  
SUPERVISORY PATENT EXAMINER

